CLAIMS

What is claimed is:

1. A method for controlling a chemical mechanical polishing (CMP) operation in a multi-variable CMP apparatus that includes a plurality of end point detection probes, the method comprising the steps of:

obtaining a thickness profile of a first layer overlying a first work piece;

estimating an expected removal rate profile for the first layer;

calculating a predicted clearing time profile for the first layer based upon the thickness profile and the expected removal rate profile;

determining an expected range of radial position for each of the plurality of end point detectors during a CMP operation;

calculating an expected probe detection time for each of the plurality of end point detection probes based on the clearing time profile and the expected range of radial position;

setting each variable of the multi-variable CMP apparatus to a first setting;

polishing the first layer overlying the first work piece;

measuring an actual probe detection time for each of the plurality of end point detection probes;

calculating a time correction coefficient relating actual probe detection time to expected probe detection time for each of the plurality of end point detection probes; and

constructing an actual removal rate profile based on the expected removal rate profile and the calculated time correlation coefficients.

2. The method of claim 1 further comprising the steps of:

obtaining a thickness profile of a second layer overlying a second work piece;

setting each variable of the multi-variable CMP apparatus to a second setting in response to the step of constructing an actual removal rate profile and obtaining the thickness profile of the second layer; and

polishing the second layer overlying the second work piece with each variable of the multi-variable CMP apparatus set to the second setting.

3. The method of claim 2 wherein the step of setting each variable of the multi-variable CMP apparatus to a second setting comprises the step of setting each variable of the multi-variable CMP apparatus to a second setting in which the second setting is different than the first setting with respect to at least one variable.

4. The method of claim 1 wherein the step of obtaining a thickness profile comprises the step of selecting a value from a list consisting of a measured profile and a profile representative of the equipment used to deposit the first layer.

5. The method of claim 1 wherein the step of calculating a predicted clearing time profile comprises the step of dividing the thickness profile by the expected removal rate profile.

6. The method of claim 1 wherein the step of calculating a predicted clearing time profile comprises the step of dividing the thickness profile less a constant factor by the expected removal rate profile.

7. The method of claim 1 wherein the step of calculating a time correction coefficient comprises the step of dividing the actual probe detection time for each of the plurality of end point detection probes by the expected probe detection time for each of the plurality of end point detection probes.

8. The method of claim 7 further comprising the step of extrapolating the results of dividing to create a continuous spatial function of time correction coefficient.

9. A method for controlling a chemical mechanical polishing (CMP) operation on a layer overlying a surface of a work piece in a CMP apparatus having a plurality of settable process variables and a plurality of end point detection probes, the method comprising the steps of:

estimating an expected removal rate profile for a first layer overlying a first work piece;

setting the plurality of process variables to a first setting;

determining an expected end point detection time for the first layer for each of the plurality of end point detection probes;

polishing the first layer with the plurality of process variables set to the first setting;

measuring an actual end point detection time for the first layer for each of the plurality of end point detection probes; and

constructing an actual removal rate profile for the first layer based on the expected removal rate profile, the expected end point detection time for each of the plurality of end point detection probes, and the actual end point detection time for each of the plurality of end point detection probes.

10. The method of claim 9 further comprising the steps of:

obtaining a profile of a second layer overlying a second work piece;

setting at least one of the plurality of process variables to a second setting in response to the step of constructing an actual removal rate profile for the first layer; and

polishing the second layer with at least one of the plurality of process variables set to the second setting.

11. The method of claim 10 wherein the step of setting at least one of the plurality of process variables comprises the step of setting at least one of the plurality of process variables to a second setting different than the first setting.

12. The method of claim 11 further comprising the step of constructing an actual removal rate profile for the second layer.

13. The method of claim 12 wherein the step of constructing an actual removal rate profile for the second layer comprises the steps of:

estimating an expected removal rate profile for the second layer overlying the second work piece;

determining an expected end point detection time for polishing the second layer for each of the plurality of end point detection probes;

measuring an actual end point detection time for polishing the second layer for each of the plurality of end point detection probes; and

calculating the actual removal rate profile for the second layer based on the expected removal rate profile for the second layer, the expected end point detection time for polishing the second layer, and the actual end point detection time for polishing the second layer.

14. A method for controlling a chemical mechanical polishing (CMP) operation in a CMP apparatus having a plurality of end point detection probes and in which a plurality of process variables can be set to adjust the removal rate across a layer that is to be polished, the method comprising the steps of:

setting the plurality of process variable to a first setting;

determining an expected end point detection response from each of the plurality of end point detection probes;

polishing a first layer on a first work piece with the process variables set to the first setting;

observing an actual end point detection response from each of the plurality of end point detection probes;

determining a difference between the expected end point detection response and the actual end point detection response;

adjusting at least one of the plurality of process variables to a second setting; and

polishing a second layer overlying a second work piece with the plurality of process variables set to the second setting.

15. The method of claim 14 further comprising the step of calculating a time correction coefficient equal to the actual end point detection response divided by the expected end point detection response for each of the plurality of end point detection probes.

16. The method of claim 15 further comprising the step of constructing an actual removal rate profile based on the calculated time correction coefficients.

17. The method of claim 16 wherein the step of adjusting at least one of the plurality of process variables comprises the step of adjusting at least one of the plurality of process variables in response to the actual removal rate profile.

18. A method for controlling a chemical mechanical polishing (CMP) operation in a CMP apparatus having a plurality of end point detection probes and in which a plurality of process variables can be set to adjust the removal rate across a layer that is to be polished, the method comprising the steps of:

obtaining an incoming profile for a first surface of a first work piece to be polished;

calculating an expected clearing time profile based on the incoming profile for the first surface;

calculating an expected end point detection response for the plurality of end point detection probes in response to the expected clearing time profile;

polishing the first surface of the first work piece;

observing an actual end point detection response for the plurality of end point detection probes as the first surface of the first work piece is polished; and

constructing a removal rate profile for the first surface of the first work piece based on differences between the expected end point detection response and the actual end point detection response.

19. The method of claim 18 further comprising the steps of:

obtaining an incoming profile for a second surface of a second work piece to be polished;

adjusting at least one of the plurality of process variables to a second setting in response to constructing a removal rate profile; and

polishing the second surface using the second setting.

20. The method of claim 19 further comprising the step of constructing a removal rate profile for the second surface of the second work piece.

21. A method for controlling a chemical mechanical polishing (CMP) operation in a CMP apparatus having a plurality of end point detection probes and in which a plurality of process variables can be set to adjust the removal rate across a layer that is to be polished, the method comprising the steps of:

setting the plurality of process variables to a first setting;

polishing a first layer overlying a first work piece to remove the first layer using the first setting for the plurality of process variables;

collecting information from the plurality of end point detection probes;

evaluating the information from the plurality of end point detection probes to determine removal rate of the first layer across the first work piece;

adjusting the plurality of process variables to a second setting in response to evaluating the information; and

polishing a second layer overlying a second work piece using the second setting for the plurality of process variables.